CHEMICAL HAZARD SUMMARY
Canadian Centre for Occupational Health and Safety
250 Main Street East
Hamilton Ontario Canada L8N 1H6
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# BROMOTRIFLUOROMETHANE

| | |
|---|---|
| Other Names | Fluorocarbon 1301, trifluorobromomethane, trifluoromonobromomethane, (trade names include Halon 1301 and Freon 13B1) CBrF3, CAS 75-63-8 |
| Description | Dense, colourless, odourless gas. Liquid at very high pressures. |

## HAZARD SUMMARY

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| Exposure | As a gas – through inhalation and eye contact.<br><br>As a liquid – through skin or eye contact. |
| Effects of Short-Term Exposure | At exposures above 1,000 ppm, gas causes irritation of eyes and nose, light-headedness, slight dizziness, a feeling of drunkenness, slight numbness. Massive exposure may cause irregular heartbeat.<br><br>Liquid causes frostbite and skin burns. |
| Effects of Repeated or Long-Term Exposure | Limited information is available on long-term effects; no health effects are seen in animals with long-term exposure at concentrations up to 2.3% (23,000 ppm). |
| Personal Protection | To protect skin from contact with liquid, wear gloves, coveralls and boots. Material for protective clothing should be resistant to cold and be made of Viton, Teflon, butyl rubber or neoprene. To protect eyes from accidental contact with liquid, wear chemical-splash goggles. A face shield may also be necessary to protect the face. If gas concentrations exceed exposure limits, wear appropriate respiratory protection. |
| Chemical Reactivity | Avoid heat and contact with chemically active metals, sodium, potassium, magnesium and powdered aluminum which can react violently. |
| Fire and Explosion Hazards | Non-flammable. Non-explosive. |
| Fire-Fighting | Not applicable. This material is used as a fire-extinguishing agent. |

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| Storage and Handling | Bromotrifluoromethane must be stored in closed, pressurized systems. Store compressed gas cylinders secured with chains, in an upright position at temperatures under 54 deg C (130 deg F). |
| Clean-Up and Disposal | Wear protective clothing and respirators to prevent overexposure. Ventilate the area. Stop leaks and allow gas to disperse. Comply with environmental regulations. |
| Exposure Limits | As recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) 1986-87.<br><br>Time-Weighted Average Exposure (TLV-TWA):<br>1,000 ppm (parts per million) or<br>6,100 mg/m$^3$ (milligrams per cubic metre) |

TWA is defined as the time-weighted average concentration for a normal 8-hour workday and a 40-hour workweek.

## SCOPE OF THE DOCUMENT

This summary was prepared at the Canadian Centre for Occupational Health and Safety (CCOHS) and is intended primarily as a source of information for persons who work with or may be occupationally exposed to this material. The information selected for inclusion is believed to be reliable and generally relevant to occupational health. Other information may be available which bears on particular work situations. The scientific data in many areas are limited and may allow a variety of interpretations. Additional information, corrections, comments, and questions are welcome, and should be addressed to the Inquiries Office, CCOHS, 250 Main Street East, Hamilton, Ontario, L8N 1H6, (416) 572-2981.

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## I. USES AND OCCURRENCE

Bromotrifluoromethane is used mainly as a fire-extinguishing agent. It was first used in portable extinguishers in 1959, and is now widely used in total flooding sprinkler systems and local application systems at concentrations of 5-7% (50,000 to 70,000 parts per million). It is also used in pressurized refrigeration systems.

Bromotrifluoromethane is used in metal and pharmaceutical processing, in local anesthetics, in glass chillers and in the manufacture of olefin resins.

Bromotrifluoromethane may be added to hydraulic fluids to reduce erosion.

## II. TOXICOLOGY

**Routes of Exposure**

Bromotrifluoromethane occurs as a gas at normal room temperature and pressure. Thus, inhalation of bromotrifluoromethane gas is the major route of occupational exposure. Because bromotrifluoromethane

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can be liquefied under high pressure, there may be eye and skin contact with the liquid. If a sudden large release occurs, bromotrifluoromethane liquid will evaporate quickly.

General information on routes of exposure is available in the CCOHS publication "How Workplace Chemicals Enter the Body"[1].

**Removal from the Body**

Bromotrifluoromethane tends to collect temporarily in fatty tissues before it is eliminated[2]. It is eliminated from the body in exhaled air. The amount of bromotrifluoromethane in the body halves in about fifteen minutes.

**Effects of Short-Term Exposures in Humans**

Bromotrifluoromethane is usually studied in relation to other common halogenated hydrocarbons such as the refrigerant gases (chlorofluorocarbons) and anesthetics. Studies on short-term exposure to this chemical have focused on effects which occur during its use as a fire-extinguishing agent in confined spaces.

**Inhalation**

Human studies indicate that bromotrifluoromethane is low in toxicity but can affect the central nervous system and the heart at very high concentrations.

At concentrations between 5-17% (50,000 - 170,000 ppm), bromotrifluoromethane can affect the central nervous system and may cause light-headedness, numbness, tingling and drunkenness. There have been reports of slight decreases in judgement, alertness, or coordination; buzzing in the ears; and a feeling of gradually losing consciousness. However, unconsciousness in humans has not occurred either experimentally or in the workplace. Effects experienced are temporary, and complete recovery is rapid upon breathing fresh air[3].

Breathing very high levels (over 15% or 150,000 ppm) of bromotrifluoromethane for 15 to 25 minutes can affect the heart and blood vessels. Sudden changes in heart rhythm, such as irregular heartbeat, develop. Since most fire-fighting systems reach 5-7% bromotrifluoromethane in air, these effects should not develop[4]. No heart effects occurred when human volunteers were exposed at 1-10% (10,000-100,000 ppm) concentrations for 3.0 to 3.5 minutes[3].

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**Effects on the Skin**
Bromotrifluoromethane is a liquid only under high pressure (as in a compressed gas cylinder). Its sudden release from a pressurized container could result in skin contact. The liquid rapidly evaporates from the skin resulting in localized frostbite. Recovery is usually complete. However, there are no actual reports of occupational exposure to liquid bromotrifluoromethane.

**Effects on the Eyes**
When released, bromotrifluoromethane fire-suppression systems may produce a slight fog which can reduce visibility for a few seconds.

There are reports of eye irritation after bromotrifluoromethane fire-suppression systems have been set off. There is some doubt about whether bromotrifluoromethane alone is responsible for causing eye irritation. Other air contaminants may cause or contribute to the irritation[4,5].

Irritating effects on the eyes may be caused by chemical by-products produced during a fire, or by the breakdown of bromotrifluoromethane above 538°C (1,000°F).

Eye contact with liquid bromotrifluoromethane causes frostbite.

**Effects of Repeated or Long-Term Exposures**
The health hazards of exposure to bromotrifluoromethane, such as effects on the heart and the central nervous system, result from exposure to high concentrations or for prolonged periods.

**Reproductive Hazards**
Studies in laboratory animals are widely used to indicate the potential of a chemical to cause reproductive effects in humans. There is no evidence that bromotrifluoromethane causes birth effects in animals or humans.

**Toxicity Data in Animals**
Examination of the health effects in animals after short-term exposure to bromotrifluoromethane provides a basis for assessing the potential health effects in humans. The conditions for toxicity testing in animals are generally more severe than those of occupational exposure. The levels of chemicals to which the animals are exposed in toxicity testing are much higher than in the controlled workplace.

**Short-Term Effects in Animals**
Bromotrifluoromethane toxicity studies have been done in rabbits, mice, rats, guinea pigs and monkeys. These animals were exposed to

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concentrations from 10-80% (100,000-800,000 ppm)[3,6]. The animals did not show significant effects at various bromotrifluoromethane concentrations up to 20%. Effects associated with stimulation or depression of the central nervous system, such as tremors, convulsions, lethargy, and unconsciousness were observed. The type and intensity of these effects varied between animal species.

Bromotrifluoromethane affects heart function by causing a decreased blood pressure, a decreased heart rate and irregular heartbeat. These effects were noted in dogs exposed to concentrations at 7.5, 10, 15 and 20% (75,000; 100,000; 150,000 and 200,000 ppm)[3]. Death due to lack of oxygen has occurred in rats after a 15-minute exposure to concentrations above 83% (830,000 ppm)[2,7,8,9].

**Long-Term Exposure in Animals**
There is little information on the effects of long-term exposure in animals. What studies there are indicate that bromotrifluoromethane is low in toxicity. Rats and dogs exposed to bromotrifluoromethane at levels just above 2% (20,000 ppm) for an 18-week period did not experience permanent toxic effects[10].

## III. FIRST AID

The following general procedures are suggested [11] for first aid involving overexposure to bromotrifluoromethane through these routes:

**Inhalation**
Move the victim to fresh air or remove the source of bromotrifluoromethane. Obtain medical attention immediately.

**Skin Contact**
For frostbitten areas, rinse contaminated skin and clothing under warm water. To decrease the risk of infection, do not remove clothing that sticks to damaged skin. Instead, carefully cut around this clothing and remove the rest of the garment. To reheat damaged tissue to normal body temperature as quickly as possible, immerse the affected area in a bath of warm water (41°C to 43°C) for at least 30 minutes by the clock. Ensure the water is maintained at the correct temperature. Do not rub frostbitten areas before or after thawing. Obtain medical advice immediately.

**Eye Contact**
Remove the source of bromotrifluoromethane or move the victim to fresh air. For direct contact with vapourizing liquid, immediately flush

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the contaminated eye(s) with lukewarm, gently flowing water for 20 minutes, by the clock, holding the eyelid(s) open. Obtain medical attention immediately.

**Ingestion**
Not applicable.

**General Comments**
Provide general supportive measures (comfort, warmth, rest). Consult a physician and/or the nearest Poison Control Centre for all exposures except minor instances of inhalation. All first aid procedures should be reviewed periodically by a physician familiar with bromotrifluoromethane and its use in the workplace.

## IV. FIRE AND EXPLOSION HAZARDS

Bromotrifluoromethane is a non-flammable, non-explosive compressed gas at normal room temperature.

Since bromotrifluoromethane is non-combustible, flash point and flammable or explosive limits do not apply.

When it is used as a fire-extinguishing agent, limit exposure to 15 minutes at a concentration of 7% or less. For concentrations between 7 and 10%, limit exposure to 1 minute. For concentrations of 10 to 15%, limit the exposure time to 30 seconds. When concentrations exceed 15%, prevent all exposures. These guidelines are recommended by the American National Fire Protection Association[12].

Bromotrifluoromethane breaks down at elevated temperatures. Hydrogen bromide gas, hydrogen fluoride gas and free bromine may be formed when heated above 538°C (1,000°F)[13]. In air, carbonyl fluoride (COF) and carbonyl bromide (COBr) form[14]. These decomposition products form when bromotrifluoromethane is used to extinguish very hot fires. There is a danger of pressurized cylinders rupturing if they are heated. Therefore, keep bromotrifluoromethane cylinders away from the vicinity of a fire. If this is not possible, cool the cylinders with water[12].

Formation of break-down gases is related to factors such as intensity of the fire, the material which is burning, the size of room, the number of hot surfaces present and the length of time the fire has been burning[15].

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**Chemical Reactivity**
Bromotrifluoromethane is normally stable at temperatures below 538°C, in light, air, acids and bases. It reacts violently with active metals, sodium, potassium, powdered aluminum[16] and magnesium. Liquid bromotrifluoromethane can break down some forms of plastic, rubber and coatings[14].

## V. EXPOSURE CONTROL

Overexposure to bromotrifluoromethane is best prevented by design of the work process and engineering controls. The available types of control measures include:

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| Substitution | Area ventilation |
| Isolation | Work practices |
| Enclosure | Personal hygiene |
| Local exhaust ventilation | Personal protective equipment |

One or more of these measures may be appropriate in any particular situation. A survey of the workplace and consideration of the technical requirements of the work process are usually needed before major changes are made.

Use personal and respiratory protective equipment in situations where effective ventilation and engineering controls are not possible.

**Protective Clothing**
Wear protective clothing such as gloves, coveralls and aprons as needed to prevent skin contact with liquid bromotrifluoromethane. Not all materials provide protection, so it is important to use materials which cannot be penetrated or broken down by bromotrifluoromethane. Ensure impervious protective clothing is made of Viton, Teflon, butyl rubber, neoprene, nitrile, polyvinyl chloride (PVC) or polyethylene (PE)[17]. Wear splash-proof chemical safety goggles for the eyes and a face shield (8-inch minimum) for the face if the eyes or face are likely to come in contact with liquid bromotrifluoromethane.

Immediately remove clothing contaminated with liquid bromotrifluoromethane.

**Respiratory Protection**
Wear approved respiratory protection if the airborne concentration of bromotrifluoromethane cannot be controlled. If respiratory protection is required, institute a complete respiratory protection program.

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Include in the program selection of appropriate respirators, fit testing, training, maintenance, inspection, cleaning and evaluation. (Refer to the CSA Standard Z94.4-M1982, "Selection, Care, and Use of Respirators," available from the Canadian Standards Association, Rexdale, Ontario, M9W 1R3).

The concentration of bromotrifluoromethane gas and the duration of exposure determine the degree of respiratory protection required. The National Institute for Occupational Safety and Health (NIOSH)[18] recommends that respiratory protection be used as follows*:

Gas concentrations of 10,000 ppm (60,900 mg/m$^3$) or less:
Any supplied-air respirator, or
Any self-contained breathing apparatus.

Gas concentrations of 25,000 ppm (152,250 mg/m$^3$) or less:
Any supplied-air respirator operated in a continuous-flow mode.

Gas concentrations of 50,000 ppm (304,500 mg/m$^3$) or less:
Any self-contained breathing apparatus with a full facepiece, or
Any supplied-air respirator with a full facepiece, or
Any supplied-air respirator with a tight-fitting facepiece operated in a continuous-flow mode.

Gas concentrations exceeding 50,000 ppm (304,500 mg/m$^3$) or emergency or planned entry in unknown concentration or Immediately Dangerous to Life or Health (IDLH) conditions**:
Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive-pressure mode, or
Any supplied-air respirator with a half-mask and operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode.

*Note: These recommendations apply only to NIOSH and MSHA approved respirators.

**Note: For the purpose of respirator selection, the IDLH level represents the maximum concentration from which one could escape within 30 minutes without any escape-impairing symptoms or any irreversible health effects.

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Escape:
Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapour canister, or
Any appropriate escape-type self-contained breathing apparatus.

The useful life of a respirator depends on the number and capacity of the cartridges, the concentration of gas, the temperature, and the rate of breathing. Please note that air-purifying respirators do not protect in low-oxygen atmospheres.

## VI. SMALL-SCALE STORAGE AND HANDLING

Store bromotrifluoromethane in cylinders in a clean, dry area, away from heat, flame or active metals. Since cylinders containing bromotrifluoromethane have fragile discs as safety devices, do not heat them above 50°C[19]. This will prevent a build-up of pressure which could cause the disc to rupture. The cylinders are made of steel and equipped with brass valves[20]. Store cylinders upright on a level floor or platform, secured in position and protected from damage. Label empty cylinders "Empty", particularly when bromotrifluoromethane is to be used as a fire-extinguishing agent.

Transport cylinders by hand truck or cart specifically designed for the purpose. Avoid handling cylinders with oily hands or lifting them by their caps. Do not remove the valve cap on the cylinder until the cylinder is secured. Keep the cylinder valves closed when not in actual use (an exception is in bromotrifluoromethane sprinkler systems where valves are left open since the cylinders are hooked up to the automatic sprinklers).

**Clean-Up and Disposal**
After a leak, ventilate the area to remove bromotrifluoromethane vapour. Provide protective clothing and respirators for appropriately trained clean-up personnel. For people not wearing protective equipment, restrict access to the area until the clean-up is completed.

When this compound is used as a fire-fighting agent in a total flooding system, provide a mechanism to ensure a delay between setting the alarm off and the release of bromotrifluoromethane. This allows time for people to leave the area. Install warning and instruction signs, as well as emergency lighting and directional signals to ensure quick evacuation. When outside the building, keep

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personnel upwind and out of low areas since bromotrifluoromethane is heavier than air[12]. In the case of leaks, find out where they are, stop the leakage and allow gas to disperse.

Before disposing of bromotrifluoromethane, review federal, provincial and local government requirements.

## VII. EXPOSURE LIMITS

In many Canadian jurisdictions, exposure limits are similar to the Threshold Limit Values (TLVs) recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). For bromotrifluoromethane the 1986-87 recommended TLVs are[21]:

1. Threshold Limit Value-Time Weighted Average (TLV-TWA) =
   1,000 parts per million (ppm) or 6,100 milligrams per cubic metre ($mg/m^3$):

   This is "the time-weighted average concentration for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect."

Certain Canadian jurisdictions have adopted the entire set of ACGIH TLVs for chemical substances by reference in their regulations. Others use the TLVs as guidelines for control of airborne contaminants. Still others specify exposure limits for chemical substances, including OSHA, in their regulations. Since the manner in which exposure limits are established, interpreted and implemented can vary among the jurisdictions, detailed information should be obtained from the appropriate government agency in each jurisdiction.

According to the preface in the ACGIH booklet[21]:

"Threshold limit values refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect. Because of wide variation in individual susceptibility, however, a small percentage of workers may experience discomfort from some substances at concentrations at or below the threshold limit; a smaller percentage may be affected more seriously by aggravation of a pre-existing condition or by development of an occupational illness."

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> "Threshold limits are based on the best available information from industrial experience, from experimental human and animal studies and, when possible, from a combination of the three."
>
> "The TLV-TWA should be used as guides in the control of health hazards and should not be used as fine lines between safe and dangerous concentrations." (Reproduced by permission of the ACGIH).

**Warning Properties of Bromotrifluoromethane at the Exposure Limit**

For certain substances, odour or irritant properties may be useful as a short-term indicator of possibly hazardous conditions. Bromotrifluoromethane is considered to be a material with poor warning properties[14]. No odour threshold has been defined. Therefore, reliance on the odour of bromotrifluoromethane to provide warning of possible overexposure is not recommended.

**Exposure Limits in Other Nations**

The approaches or mechanisms for establishing and applying occupational exposure limits can vary widely from country to country. Information on exposure limits in a number of foreign jurisdictions is available from CCOHS.

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## VIII. CHEMICAL AND PHYSICAL PROPERTIES

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| Chemical formula | C-Br-F3 |

**Physical Properties**

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|---|---|
| Boiling point | -59°C (-74.2°F) at 740 mm Hg |
| Density | 1.54 at 25°C (water = 1) |
| Solubility | 0.03g/100 g water at 20°C. Very soluble in chloroform. |
| Evaporation rate | not applicable |
| Vapour pressure | 14.5 atmospheres at 20°C |
| Vapour density | 5.4 (air = 1) |
| Odour threshold | no data |
| Flash point | non-combustible |
| Explosive limits | not applicable |
| Autoignition temperature | not applicable |

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Note: Additional references on this subject are available from CCOHS upon request.

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